

**REMARKS**

The specification has been amended to insert a reference to the PCT application and the Japanese priority documents.

The abstract has been amended to delete all reference numerals.

The claims have been amended to delete all multiple dependencies. It is also requested that the Examiner consider the attached translation of the Response to the Written Opinion (entitled "Written Reply (Argument)" filed by the applicants' Japanese Patent Attorneys. Examination in light of these amendments is respectfully requested.

The Examiner is invited to contact the undersigned at 202-220-4200 to discuss any matter in connection with this application.

The Office is hereby authorized to charge any fees under 37 C.F.R. 1.16 and 1.17 to the Kenyon & Kenyon Deposit Account No. 11-0600.

Respectfully submitted,



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特許審査機関

答弁書

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## 5. 答弁の内容

(1) 審査官殿は、PCT 見解書の文献および説明において、『請求の範囲 1-6, 9-12 に係る発明が、文献 1 (日本国実用新案登録出願 62-19223 0 号 (日本国実用新案登録出願公開 1-95679 号) の願書に添付した明細書および図面の内容を撮影したマイクロフィルム)、文献 2 (JP 11-346 444 A)、文献 3 (JP 2002-189066 A)、文献 4 (JP 2000-258513 A)、文献 5 (JP 9-257887 A)、文献 6 (JP 7-283774 A)、文献 7 (JP 8-43504 A)、から容易に発明をすることができた』と認められました。

しかし、本願上記請求の範囲に係る発明は前記文献とは全く相違し、本願上記請求の範囲に係る発明の基本的な技術思想に関して何ら上記文献に開示されておりません。

そこで、以下に、本願請求の範囲に係る発明と上記文献に記載の発明との相違をご説明致します。

(2) 本願請求の範囲 1, 2, 6, 10 に係る発明と文献 1, 2 に記載の発明との対比

本願特許請求の範囲 1 に係る発明は、次の通りです。

「バッテリの電圧を検出する電圧検出手段と、

バッテリの内部抵抗を推定する内部抵抗推定手段と、

前記内部抵抗推定手段により求められたバッテリの内部抵抗と前記バッテリの電圧とバッテリの開放電圧とに基づいて、バッテリの推定充放電電流を演算する推定充放電電流演算手段と、

前記推定充放電電流演算手段により求められた推定充放電電流に基づき、バッテリの充電状態 (以下 SOC という) を推定する SOC 推定手段と、

前記充放電電流の演算初回時にはバッテリの実測電圧を前記バッテリの開放電圧とし、前記演算初回以降は前回推定の SOC に基づき前記バッテリの開放電圧を演算する開放電圧演算手段と、

を有することを特徴とするバッテリ充電状態推定装置。」

本願請求の範囲 2 に係る発明は、「バッテリの電圧を検出する電圧検出手段と、バッテリの状態からバッテリの内部抵抗を推定する内部抵抗推定手段と、前記内部抵抗推定手段により求められたバッテリの内部抵抗と前記バッテリの電圧とバッテリの開放電圧とに基づいて、バッテリの推定充放電電流を演算する推定充放電電流演算手段と、

前記推定充放電電流演算手段により求められた推定充放電電流に基づき、バッテリの充電状態を推定する第 1 SOC 推定手段と、

前記充放電電流の演算初回時にはバッテリの実測電圧を前記バッテリの開放電圧とし、前記演算初回以降は前回推定の SOC に基づき前記バッテリの開放電圧を演算する開放電圧演算手段と、

を有することを特徴とするバッテリ充電状態推定装置。」であります。

さらに、本願請求の範囲 6 に係る発明は、「バッテリの充放電電流を検出する電流検出手段と、

バッテリの電圧を検出する電圧検出手段と、

前記電流検出手段により検出されたバッテリの実測充放電電流と前記電圧検出手段により検出されたバッテリの電圧とに基づき、バッテリの内部抵抗を演算する内部抵抗演算手段と、

前記内部抵抗演算手段により求められたバッテリの内部抵抗と、前記バッテリの電圧とバッテリの開放電圧とに基づいて、バッテリの推定充放電電流を演算する推定充放電電流演算手段と、

前記推定充放電電流演算手段により求められた推定充放電電流に基づき、バッテリの充電状態を推定する第 2 SOC 推定手段と、

前記充放電電流の演算初回時にはバッテリの実測電圧を前記バッテリの開放電圧とし、前記演算初回以降は前回推定の SOC に基づき前記バッテリの開放電圧を演算する開放電圧演算手段と、

を有することを特徴とするバッテリ充電状態推定装置。」であります。

また、本願請求の範囲 10 に係る発明は、「請求の範囲 1 から請求の範囲 9 の

いずれか 1 項に記載のバッテリ充電状態推定装置において、

前記第 1 SOC 推定手段、第 2 SOC 推定手段又は SOC 推定手段の少なくと

も一つの手段は、所定時間毎にSOCを推定することを特徴とするバッテリ充電状態推定装置。」であります。

一方、文献1には、予め記憶されたメモリを参照して、現在の電流量Cから放電量 $\Delta C_d$ を計算する方法が示されています。この方法では、内部抵抗rと測定周期 $\Delta t$ を用いて、放電電流 $i = (E - V) / r$ を算出し、積分 $\int i dt$ により放電電気量を計算します。

9行の記載)。但し、上述した文献1には、上記電圧Eの求め方について何ら開示されておりません。

また、文献2には、あらかじめSOCと開放電圧とのマップを電池毎に求めておき、電流検出手段により検出された電池の充放電電流  $I_b$  から、予め電池の充放電履歴を計算し、また電池の前回使用終了時から今回使用開始時までの自己放電履歴を計算して、上記充放電履歴と自己放電履歴とを加算して得られた動作履歴によって、電池の開放電圧の修正値を求め、この修正電圧により、所定の電圧とSOCとのマップから初期SOCを算出し、この電池のSOCの初期値に、電流検出手段により検出された充放電電流値の積分値を加算して疑似SOCを推定し、この疑似SOCに対応する開放電圧  $V_{oc}$  を推定することが開示されています。（文献2の段落番号 [0015] 乃至 [0016]、[0028]、図1、2の記載）。

しかしながら、上記文献1、2のいずれにも、本願請求の範囲1、2、6に係る発明における「充放電電流の演算初回時にはバッテリの実測電圧を前記バッテリの開放電圧とし、前記演算初回以降は前回推定のSOCに基づき前記バッテリの開放電圧を演算する開放電圧演算手段」について何ら開示されておらず、また示唆されてもおりません。

さらに、上記文献 1、2 のいずれにも、本願請求の範囲 1、2、6 に係る発明

において求められた『開放電圧』を用い、推定充放電電流を演算し、S O Cを推定することに関し、何ら開示されておりません。

上記構成の相違に基づき、本願請求の範囲 1, 2, 6 に係る発明は、文献 1, 2 に記載の発明およびこれらの組み合わせに比べ、以下の利点を有します。

すなわち、本願の図 3 に示すように、推定充放電電流値の積算によって推定される推定 S O C が経時で実際の S O C に収束するため、バッテリ充電状態 (S O C) の推定精度が向上するという利点を有します。

さらに詳細に説明しますと、実測電圧  $V_m$ 、内部抵抗  $R$ 、開放電圧  $V_{ocv}$  とすると以下の式 (1) が成り立ち、

$$\text{電流 } I = (V_m - V_{ocv}) / R \quad \dots (1)$$

ここで、真の電流値を  $I_{real}$  とすると、以下の式 (2) が成り立ちます。

$$\text{真の電流値 } I_{real} = (V_m - V_{ocv-real}) / R \quad \dots (2)$$

一方、開放電圧  $V_{ocv}$  を本願請求の範囲 1, 2, 6 の記載のように求めることにより、推定  $V_{ocv}$  が  $V_{ocv-real}$  より大きい場合、すなわち  $V_{ocv-real} < V_{ocv1}$  のときは、以下の式 (3) が成り立ち、

$$(V_m - V_{ocv1}) / R = I_1 < I_{real} \quad \dots (3)$$

一方、推定  $V_{ocv}$  が  $V_{ocv-real}$  より小さい場合、すなわち  $V_{ocv-real} > V_{ocv2}$  のときは、以下の式 (4) が成り立ちます。

$$(V_m - V_{ocv2}) / R = I_2 > I_{real} \quad \dots (4)$$

したがって、本願請求の範囲 1, 2, 6 に係る発明の『開放電圧』を用いることによって、推定 S O C が実際の S O C より大きいときには、本願図 3 に示すように、常に充放電電流値  $I_1$  は実際の電流値  $I_{real}$  より小さく見積もられ、一方推定 S O C が実際の S O C より小さいときは、図 3 に示すように、常に電流値  $I_2$  は実際の電流値  $I_{real}$  より大きく見積もられるので、時間の経過とともに、推定 S O C は実際の S O C に自己収束し、本発明の S O C 推定装置の推定 S O C 精度は向上するという利点を有します。

近年、電気自動車やハイブリッド自動車が普及し始め、このような電気自動車やハイブリッド自動車に搭載されるバッテリの充電状態を、より正確に把握することが切望されていることを勘案しますと、上記利点は顕著な効果であり、この

のような顕著な効果を奏する本願請求の範囲1，2，6に係る発明は、創作性の高い発明であると思料致します。

したがつて、本願請求の範囲1，2，6に係る発明は、文献1，2に記載の発明およびこれらの組み合わせに基づいて当業者が格別の困難性もなく容易に相当し得たとは認められず、本願請求の範囲1，2，6に係る発明が、進歩性を有していることは明らかであります。

さらに、本願請求の範囲6に係る発明の「電流検出手段により検出されたバッテリの実測充放電電流と前記電圧検出手段により検出されたバッテリの電圧とともに、バッテリの内部抵抗を演算する内部抵抗演算手段」について、文献1，2のいずれにも開示されておらず、また示唆されてもおりません。

上記構成の相違に基づき、本願請求の範囲6に係る発明は、文献1，2に記載の発明およびこれらの組み合わせに比べ、以下の利点を有します。  
すなわち、バッテリの実測充放電電流とバッテリの実測電圧とからバッテリの内部抵抗を演算するため、経時によりバッテリの劣化に伴いバッテリの内部抵抗が変化したとしても、推定SOCの誤差増大を抑制することができ、その結果、SOCを精度よく推定することができるという利点を有します。

上記利点は顕著な効果であり、このような効果を奏する以上、本願請求の範囲6に係る発明は、文献1，2に記載の発明およびこれらの組み合わせに基づいて当業者が格別の困難性もなく容易に相当し得たとは到底認められず、本願請求の範囲6に係る発明が、進歩性を有していることは明白です。

さらに、本願請求の範囲10に係る発明は、本願請求の範囲1，2，6に従属しており、本願請求の範囲1，2，6に係る発明が、文献1，2に記載の発明およびこれらの組み合わせから容易に想到し得ない以上、本願請求の範囲10に係る発明も文献1，2に記載の発明およびこれらの組み合わせから容易に想到し得ないことは明らかであります。

(3) 本願請求の範囲3に係る発明と文献1，3，4に記載の発明との対比  
本願請求の範囲3に係る発明は、「請求の範囲2に記載のバッテリ充電状態推定装置において、更に、バッテリの温度を検出する温度検出手段を有し、前記内

部抵抗推定手段は、バッテリの温度から内部抵抗を推定することを特徴とするバッテリ充電状態推定装置。」であります。

一方、文献3には、電池温度Tを基に二次電池の内部インピーダンスZを求め、電流の時間平均値I<sub>av</sub>と内部イオンピーダンスZとの積で電圧時間平均値V<sub>av</sub>を補正した値を開放電圧OCVとして算出し、この開放電圧OCVと電池温度Tを基に電池残量SOCを決定することが開示されております（文献3の段落番号[0008]、図3の記載）。

また、文献4には、電池に関して予め与えられた所定抵抗値r<sub>0</sub>と、電池温度Tに基づく第1の抵抗比A<sub>1</sub>と、所与の基準充電状態に基づく第2の抵抗比A<sub>2</sub>とから電池内部抵抗r=r<sub>0</sub>+A<sub>1</sub>/A<sub>2</sub>を求め、さらに充放電賃異電池の電流Iと電圧Vとから開放電圧E=V+I·rが求められることが開示されております（文献4の段落番号[0005]の記載）。

しかしながら、文献3、4は電池温度から内部抵抗を求めているものの、この内部抵抗は開放電圧を求めるのに用いられており、したがって、上記文献1に記載の装置のEに上記文献3、4で求めた開放電圧を適用したとしても、また文献1に記載の装置の現在の電気量Cから1/rを求めるのに替えて、電池温度から1/rを求めるようにしたとしても、依然として、文献3、4と文献1との組み合わせには、本願請求の範囲3が従属する本願請求の範囲2に係る発明の「充放電電流の演算初回時にはバッテリの実測電圧を前記バッテリの開放電圧とし、前記演算初回以降は前回推定のSOCに基づき前記バッテリの開放電圧を演算する開放電圧演算手段」について、何ら開示されておらず、また示唆されてもおりません。

上記構成の相違に基づき、本願請求の範囲2に従属する本願請求の範囲3に係る発明は、文献1、3、4に記載の発明およびこれらの組み合わせに対して、上述したように、推定充放電電流値の積算によって推定される推定SOCが実際のSOCに経時で収束するため、バッテリ充電状態（SOC）の推定精度が向上するという利点を有します。

上記利点は顕著な効果であり、このような効果を奏する以上、本願請求の範囲3に係る発明は、文献1、3、4に記載の発明およびこれらの組み合わせに基づ

いて当業者が格別の困難性もなく容易に相当し得たとは到底認められず、本願請求の範囲 3 に係る発明が、進歩性を有していることは明白であります。

(4) 本願請求の範囲 4, 5 に係る発明と文献 1 乃至 4, 5 に記載の発明との対比

本願請求の範囲 4 に係る発明は、「請求の範囲 2 又は請求の範囲 3 に記載のバッテリ充電状態推定装置において、

更に、バッテリの充放電電流を検出する電流検出手段と、

前記電流検出手段により検出されたバッテリの実測充放電電流と前記電圧検出手段により検出されたバッテリの電圧とに基づき、バッテリの内部抵抗を演算する内部抵抗演算手段と、

前記内部抵抗推定手段により推定される推定内部抵抗を、間欠的に前記内部抵抗演算手段により求められた内部抵抗に基づき補正する内部抵抗補正手段と、

を有することを特徴とするバッテリ充電状態推定装置。」であります。

また、本願請求の範囲 5 に係る発明は、「請求の範囲 3 又は請求の範囲 4 に記載のバッテリ充電状態推定装置において、前記内部抵抗補正手段は、前記内部抵抗演算手段により求められた内部抵抗と実測バッテリ温度とから、推定内部抵抗とバッテリの温度との関係を補正することを特徴とするバッテリ充電状態推定装置。」であります。

一方、文献 5 には、所定時間毎に二次電池の内部インピーダンスを算出して、隨時更新された内部インピーダンスを用いて無負荷電圧  $V_0$  を求めることが開示されております。

しかしながら、文献 5 には、本願請求の範囲 4, 5 が直接又は間接的に從属する本願請求の範囲 2 に係る発明の「充放電電流の演算初回時にはバッテリの実測電圧を前記バッテリの開放電圧とし、前記演算初回以降は前回推定の S O C に基づき前記バッテリの開放電圧を演算する開放電圧演算手段」について、何ら開示されておらず、また示唆されてもおりません。

上記構成の相違に基づき、本願請求の範囲 2 に從属する本願請求の範囲 4, 5 に係る発明は、文献 5 に記載の発明、また文献 1 乃至 5 に記載の発明の組み合わ

せに対し、上述したように、推定充放電電流値の積算によって推定される推定S  
O Cが実際のS O Cに経時で収束するため、バッテリ充電状態（S O C）の推定  
精度が向上するという利点を有します。

上記利点は顕著な効果であり、このような効果を奏する以上、本願請求の範囲  
4、5に係る発明は、文献1乃至5に記載の発明およびこれらの組み合わせに基づいて当業者が格別の困難性もなく容易に相当し得たとは認められず、本願請求の範囲4、5に係る発明が、進歩性を有していることは明らかであります。

さらに、本願請求の範囲5に係る発明の「内部抵抗補正手段は、内部抵抗演算手段により求められた内部抵抗と実測バッテリ温度とから、推定内部抵抗とバッテリの温度との関係を補正する」ことに関し、文献1乃至5のいずれに開示されておらず、また示唆されてもおりません。

上記構成の相違に基づき、本願請求の範囲5に係る発明は、経時において、バッテリの温度に対する内部抵抗が変化したとしても、例えば定期的にバッテリ温度とバッテリの内部抵抗との相関関係を修正更新することによって、バッテリのS O C推定の経時精度をより向上させることができるという利点を有します。

上記利点は顕著な効果であり、このような効果を奏する以上、本願請求の範囲5に係る発明は、文献1乃至5に記載の発明およびこれらの組み合わせに基づいて当業者が格別の困難性もなく容易に相当し得たとは到底認められず、本願請求の範囲5に係る発明が、進歩性を有していることは明らかであります。

#### （5）本願請求の範囲9に係る発明と文献1乃至5、6に記載の発明との対比

本願請求の範囲9に係る発明は、「請求の範囲3または請求の範囲5に記載のバッテリ充電状態推定装置において、前記温度検出手段は、バッテリの内部あるいはバッテリ表面又は表面近傍に設置されていることを特徴とするバッテリ充電状態推定装置。」であります。

一方、文献6には、携帯電話用電池内部に温度検出器を設けるなどして携帯電話の内部温度を測定することにより電池残量表時を行うことが記載されております。

しかしながら、文献6には、本願請求の範囲9が間接的に従属する本願請求の

範囲 2 に係る発明の「充放電電流の演算初回時にはバッテリの実測電圧を前記バッテリの開放電圧とし、前記演算初回以降は前回推定の S O C に基づき前記バッテリの開放電圧を演算する開放電圧演算手段」について、何ら開示されておらず、また示唆されてもおりません。

上記構成の相違に基づき、本願請求の範囲 2 に間接的に従属する本願請求の範囲 9 に係る発明は、文献 6 に記載の発明、また仮に文献 1 乃至 5, 6 に記載の発明の組み合わせに対し、上述したように、推定充放電電流値の積算によって推定される推定 S O C が実際の S O C に経時で収束するため、バッテリ充電状態 (S O C) の推定精度が向上するという利点を有します。

上記利点は顕著な効果であり、このような効果を奏する以上、本願請求の範囲 4, 5 に係る発明は、文献 1 乃至 5, 6 に記載の発明およびこれらの組み合わせに基づいて当業者が格別の困難性もなく容易に相当し得たとは認められず、本願請求の範囲 9 に係る発明が、進歩性を有していることは明白です。

#### (6) 本願請求の範囲 1 1, 1 2 に係る発明と文献 1 乃至 5, 7 に記載の発明との対比

本願請求の範囲 1 1 に係る発明は、「請求の範囲 1 から請求の範囲 3 のいずれか 1 項に記載のバッテリ充電状態推定装置において、

更に、バッテリの充放電電流を検出する電流検出手段と、

前記 S O C 推定手段又は第 1 S O C 推定手段により推定された S O C と、前記 S O C 推定中の前記電流検出手段により検出されるバッテリの充放電電流の積算値とに基づき、バッテリの全容量を求める第 1 のバッテリ全容量算出手段と、

前記第 1 のバッテリ全容量算出手段により得られたバッテリ全容量と、前記電流検出手段により検出されたバッテリの実測充放電とに基づきバッテリの充電状態を推定する第 3 S O C 推定手段と、

を有することを特徴とするバッテリ充放電状態推定装置。」であります。

また、本願請求の範囲 1 2 に係る発明は、「請求の範囲 4 から請求の範囲 8 のいずれか 1 項に記載のバッテリ充放電状態推定装置において、

更に、前記第 1 S O C 推定手段又は第 2 S O C 推定手段により推定された S O

Cと、前記S O C推定中の前記電流検出手段により検出されたバッテリの充放電电流の積算値に基づき、バッテリの全容量を求める第2のバッテリ全容量算出手段と、

前記第2のバッテリ全容量算出手段により得られたバッテリ全容量と、前記電流検出手段により検出されたバッテリの実測充放電电流とに基づきバッテリの充電状態を推定する第4 S O C推定手段と、

を有することを特徴とするバッテリの充放電状態推定装置。」であります。

一方、文献7には、主電池の放電中において、主電池の電離電圧（V）・放電电流（i d）・温度（T）を計測し、放電特性によりこの時点での基準残容量（A h<sub>1</sub>）を残存容量割合S O C（%）に関連して演算し、一方、残存容量割合S O C 1 0 0 %のときの残存容量絶対値（A h<sub>0</sub>）が満充電容量Q<sub>0</sub>（A h）として、残容量絶対値（A h<sub>0</sub>）と基準残容量（A h<sub>1</sub>）との誤差△ A h<sub>0</sub>を求め、平均値 [△ A h<sub>N0</sub>] = ([△ A h<sub>1</sub>] + ⋯ + [△ A h<sub>N</sub>] / N) を計算し、満充電容量Q<sub>0</sub>=初期の満充電容量（Q<sub>00</sub>）- [△ A h<sub>N0</sub>] として、初期の満充電容量Q<sub>00</sub>からの劣化を補正し、現在の満充電時の残存容量の絶対値A h<sub>0</sub>と上記満充電容量Q<sub>0</sub>との誤差が所定値以上の場合A h<sub>00</sub>をQ<sub>0</sub>に置換して、残存容量割合S O C（%）= [{A h<sub>00</sub> × k i × k t} - ∫ i d t] / (A h<sub>00</sub> × k i × k t) × 1 0 0 の式のA h<sub>00</sub>を補正しながら、満充電時の残存容量を求めることが開示されております（文献7の段落番号[0 0 1 6]、[0 0 1 7]、[0 0 2 6]乃至[0 0 3 3]、図2、3、5の記載）。

しかしながら、文献7および上述した文献1乃至5には、本願請求の範囲1 1が従属する本願請求の範囲1、2に係る発明、および本願請求の範囲1 2が間接的に従属する本願請求の範囲1、2、6に係る発明の「充放電电流の演算初回時にはバッテリの実測電圧を前記バッテリの開放電圧とし、前記演算初回以降は前回推定のS O Cに基づき前記バッテリの開放電圧を演算する開放電圧演算手段」について、何ら開示されておらず、また示唆されてもおりません。

上記構成の相違に基づき、本願請求の範囲1、2に従属する本願請求の範囲1 1に係る発明、および本願請求の範囲1、2、6に従属する本願請求の範囲1 2に係る発明は、文献1乃至5、文献7に記載の発明およびこれらの組み合わせに

対し、上述したように、推定充放電電流値の積算によって推定される推定S O Cが実際のS O Cに経時で収束するため、バッテリ充電状態（S O C）の推定精度が向上するという利点を有します。

上記利点は顕著な効果であり、このような効果を奏する以上、本願請求の範囲11，12に係る発明は、文献1乃至5，7に記載の発明およびこれらの組み合わせに基づいて当業者が格別の困難性もなく容易に相当し得たとは認められず、本願請求の範囲11，12に係る発明が、進歩性を有していることは明らかであります。

(7) 以上説明致しましたように、文献1乃至7のいずれにも本発明の特徴的な構成要件が何ら開示されておらず、上記文献から到底本発明を推考するに至ったとは認めることができません。

更に本発明の特徴事項である「充放電電流の演算初回時にはバッテリの実測電圧を前記バッテリの開放電圧とし、前記演算初回以降は前回推定のS O Cに基づき前記バッテリの開放電圧を演算する開放電圧演算手段」という構成要件が上記文献に示唆されているならばともかく、このような何らの示唆もない以上本発明が上記文献から容易に発明をすることができたとは到底認めることができず、再度ご審査の上、本願請求の範囲1-6，9-12も進歩性が「有」との見解を賜りたくお願いする次第です。

以上

**Written Reply (Argument)****5. Argument**

(1) The Examiner states in the References and Explanation section of the PCT Opinion that "the inventions of Claims 1 through 6 and 9 through 12 could have been easily be made based on Reference 1 (Microfilm containing images of a specification and drawings attached to Japanese Utility Model Application No. 62-192230 (Japanese Utility Model Laid-Open Publication No. 1-95679)), Reference 2 (JP 11-346444A), Reference 3 (JP 2002-189066A), Reference 4 (JP 2000-258513A), Reference 5 (JP 9-257887A), Reference 6 (JP 7-283774A), and Reference 7 (JP 8-43504A).

However, the inventions described in these claims of the present application completely differ from the references and none of the references discloses the basic technical ideas in the inventions of the above-described claims.

The applicant therefore describes the differences between the inventions disclosed in these claims of the present application and the inventions described in the references.

(2) Comparison between the inventions described in Claims 1, 2, 6, and 10 of the present application and the inventions described in References 1 and 2

The invention described in Claim 1 of the present application is:

"A battery state-of-charge estimator comprising:  
a voltage detector unit which detects a voltage of a battery;  
an internal resistance estimator unit which estimates an internal resistance of the battery;  
an estimated charging/discharging current calculator

unit which calculates an estimated charging/discharging current of the battery based on the internal resistance of the battery determined by the internal resistance estimator unit, the voltage of the battery, and an open voltage of the battery;

an SOC estimator unit which estimates a state of charge (hereinafter referred to as 'SOC') of the battery based on the estimated charging/discharging current determined by the estimated charging/discharging current calculator unit; and

an open voltage calculator unit which sets the measured voltage of the battery as the open voltage of the battery at an initial calculation of the charging/discharging current and, after the initial calculation, calculates the open voltage of the battery based on the SOC which is previously estimated".

The invention of Claim 2 is:

"A battery state-of-charge estimator comprising:

a voltage detector unit which detects a voltage of a battery;

an internal resistance estimator unit which estimates an internal resistance of the battery from a state of the battery;

an estimated charging/discharging current calculator unit which calculates an estimated charging/discharging current of the battery based on the internal resistance of the battery determined by the internal resistance estimator unit, the voltage of the battery, and an open voltage of the battery;

a first SOC estimator unit which estimates a state of charge of the battery based on the estimated charging/discharging current determined by the estimated charging/discharging current calculator unit; and

an open voltage calculator unit which sets the measured voltage of the battery as the open voltage of the battery at an initial calculation of the charging/discharging current and, after the initial calculation, calculates the open voltage of the battery based on the SOC which is previously estimated".

The invention described in Claim 6 is:

"A battery state-of-charge estimator comprising:  
a current detector unit which detects a charging/discharging current of a battery;  
a voltage detector unit which detects a voltage of the battery;  
an internal resistance calculator unit which calculates an internal resistance of the battery based on the measured charging/discharging current of the battery which is detected by the current detector unit and the voltage of the battery which is detected by the voltage detector unit;  
an estimated charging/discharging current calculator unit which calculates an estimated charging/discharging current of the battery based on the internal resistance of the battery which is determined by the internal resistance calculator unit, the voltage of the battery, and an open voltage of the battery;  
a second SOC estimator unit which estimates a state of charge of the battery based on the estimated charging/discharging current which is determined by the estimated charging/discharging current calculator unit; and  
an open voltage calculator unit which sets the measured voltage of the battery as the open voltage of the battery at an initial calculation of the charging/discharging current and, after the initial calculation, calculates the open voltage of the battery based on the SOC which is previously estimated".

The invention described in Claim 10 is:

"A battery state-of-charge estimator according to any one of Claims 1 through 9, wherein  
at least one of the first SOC estimator unit, the second SOC estimator unit, and the SOC estimator unit periodically estimates the SOC at a predetermined interval".

Reference 1, on the other hand, discloses a charge/discharge

monitoring device for a battery in which  $k_3$  ( $1/r$  ( $r$  is an internal resistance)) is calculated from a present amount of current  $C$  by referring to a memory which is stored in advance; an amount of discharge  $\Delta C_d$  per a measurement period  $\Delta t$  is determined using  $k_3$  as  $k_3(E-V)\Delta t$  ( $E$  represents a voltage when the internal resistance is zero and  $V$  represents a terminal voltage between terminals of the battery); a new present amount of electricity  $C$  is determined by subtracting the amount of discharge  $\Delta C_d$  from the present amount of electricity  $C$ ; and a ratio of remaining amount in the discharge is determined. Reference 1 further discloses that the amount of discharging electricity can be determined by equations of discharging current  $i = (E - V)/r$  and an amount of discharging electricity  $C = \int idt$  (in Reference 1, description from page 9, line 12 to page 10, line 1, Figs. 7 and 10, and description on page 3, lines 1 through 19).

However, Reference 1 fails to disclose how the voltage  $E$  is determined.

Reference 2 discloses that a map between an SOC and an opening voltage is determined for each battery in advance; a charging/discharging history of a battery is calculated in advance from a charging/discharging current  $I_b$  of the battery detected by a current detector unit; a self-discharging history from the time of completion of previous usage of the battery to the time of start of current usage of the battery is calculated; a corrected value of the discharging voltage of the battery is determined based on an operation history obtained by combining the charging/discharging history and the self-discharging history; an initial SOC is calculated from the corrected voltage and a predetermined map between the voltage and SOC; a simulated SOC is estimated by adding an integrated value of the charging/discharging current value detected by the current detector unit to the initial value of the SOC of the battery; and the open voltage  $V_{oc}$  corresponding to the simulated SOC is estimated (in Reference 2, paragraphs [0015] through [0016] and

[0028], and Figs. 1 and 2).

However, Reference 1 and Reference 2 fail to disclose or even suggest "an open voltage calculator unit which sets the measured voltage of the battery as the open voltage of the battery at an initial calculation of the charging/discharging current and calculates the open voltage of the battery based on the SOC which is previously estimated after the initial calculation" as described in Claims 1, 2, and 6 of the present application.

In addition, neither Reference 1 nor Reference 2 discloses calculation of the estimated charging/discharging current using the "open voltage" determined in Claims 1, 2, and 6 of the present application to estimate the SOC.

With the structural differences described above, the inventions of Claims 1, 2, and 6 of the present application have the following advantage over the inventions of References 1 and 2 and a combination thereof.

As shown in Fig. 3 of the present application, the estimated SOC which is estimated through integration of the estimated charging/discharging current value converges to the actual SOC as time elapses, and therefore, there is an advantage that estimation precision of the state of charge (SOC) of the battery can be improved.

More specifically, when the measured voltage is  $V_m$ , the internal resistance is  $R$ , and the open voltage is  $V_{ocv}$ , the following equation (1) is satisfied.

$$\text{Current } I = (V_m - V_{ocv}) / R \quad (1)$$

When the real current value is  $I_{real}$ , the following equation (2) is satisfied.

$$\text{Real current value } I_{\text{real}} = (V_m - V_{\text{ocv-real}}) / R \quad (2)$$

By determining the open voltage  $V_{\text{ocv}}$  as described in Claims 1, 2, and 6 of the present application, the following equation (3) is satisfied for a case when the estimated  $V_{\text{ocv}}$  is greater than  $V_{\text{ocv-real}}$ , that is, when  $V_{\text{ocv-real}} < V_{\text{ocv1}}$ :

$$(V_m - V_{\text{ocv1}}) / R = I_1 < I_{\text{real}} \quad (3)$$

On the other hand, the following equation (4) is satisfied when the estimated  $V_{\text{ocv}}$  is smaller than  $V_{\text{ocv-real}}$ , that is, when  $V_{\text{ocv-real}} > V_{\text{ocv2}}$ .

$$(V_m - V_{\text{ocv2}}) / R = I_2 > I_{\text{real}} \quad (4)$$

Therefore, when the "open voltage" in the inventions of Claims 1, 2, and 6 of the present application is used, as shown in Fig. 3, the charging/discharging current value  $I_1$  is always estimated to be smaller than the actual current value  $I_{\text{real}}$  when the estimated SOC is greater than the actual SOC and the current value  $I_2$  is always estimated to be greater than the actual current value  $I_{\text{real}}$  when the estimated SOC is smaller than the actual SOC, also as shown in Fig. 3. Thus, as time elapses, the estimated SOC self-converges to the actual SOC and the SOC estimator of the present invention has an advantage that precision of the estimated SOC is improved.

Considering the fact that, recently, electrical vehicles and hybrid vehicles have become popular and that there is a strong demand for more precisely knowing the state of charge of the battery equipped in such electrical vehicles and hybrid vehicles, the above-described advantage is significant and the inventions of Claims 1, 2, and 6 having such significant advantages are highly inventive.

Therefore, it would not have been easy for a person with ordinary

skill in the art to make the inventions of Claims 1, 2, and 6 of the present application without a difficulty based on the inventions described in References 1 and 2 and a combination thereof. Thus, it is clear that the inventions of Claims 1, 2, and 6 of the present application have an inventive step.

Moreover, Reference 1 and Reference 2 fail to disclose or even suggest "an internal resistance calculator unit which calculates an internal resistance of the battery based on the measured charging/discharging current of the battery which is detected by the current detector unit and the voltage of the battery which is detected by the voltage detector unit" described in the invention of Claim 6 of the present application.

With this structural difference, the invention of Claim 6 of the present application has the following advantage over the inventions of References 1 and 2 and a combination thereof.

Because the internal resistance of the battery is calculated based on the measured charging/discharging current of the battery and the measured voltage of the battery, even when the internal resistance of the battery changes due to deterioration of the battery as time elapses, it is possible to inhibit an increase in the error of the estimated SOC, and, as a result, there is an advantage that the SOC can be precisely estimated.

This advantage is significant. Because the invention of Claim 6 of the present application has such a significant advantage, it would not have been easy for a person with ordinary skill in the art to make the invention of Claim 6 based on References 1 and 2 and a combination thereof, and it is clear that the invention of Claim 6 of the present application has an inventive step.

Furthermore, Claim 10 depends from Claims 1, 2, and 6. Because the inventions of Claims 1, 2, and 6 cannot easily be made from

the inventions of References 1 and 2 and a combination thereof, it is clear that it would not have been easy to conceive the invention of Claim 10 of the present application based on the inventions of References 1 and 2 and a combination thereof.

(3) Comparison between the invention of Claim 3 of the present application and inventions disclosed in References 1, 3, and 4

The invention of Claim 3 of the present application is:

"A battery state-of-charge estimator according to Claim 2, further comprising:

a temperature detector unit which detects a temperature of the battery, wherein

the internal resistance estimator unit estimates the internal resistance based on the temperature of the battery".

Reference 3, on the other hand, discloses that an internal impedance Z of a secondary battery is determined based on a temperature T of the battery; a value in which a time average value  $V_{av}$  of voltage is corrected by a product of a time average value  $I_{av}$  of current and the internal impedance is calculated as an open voltage OCV; and SOC of amount of remaining battery is determined based on the open voltage OCV and the battery temperature T (paragraph [0008] and Fig. 3 of Reference 3).

Reference 4 discloses that an internal resistance of a battery  $r$  is determined from  $r = r_0 + A_1/A_2$  based on a predetermined resistance value  $r_0$  which is given in advance for the battery, a first resistance ratio  $A_1$  which is based on the battery temperature T, and a second resistance ratio  $A_2$  which is based on a predetermined reference state of charge and that an open voltage E is determined by  $E = V + I \cdot r$  based on the current I and the voltage V of the battery during charging/discharging (paragraph [0005] of Reference 4).

Although References 3 and 4 determine the internal resistance from the battery temperature, the internal resistance is used for determining the open voltage. Therefore, even when the open voltage determined in References 3 and 4 is applied to E of the device of Reference 1 or even when  $1/r$  of Reference 1 is determined from the battery temperature instead of the present amount of electricity C, the combination of Reference 1 and Reference 3 or 4 still does not disclose or even suggest the structure of the present invention, described in Claim 2 of the present application from which Claim 3 depends, of "an open voltage calculator unit which sets the measured voltage of the battery as the open voltage of the battery at an initial calculation of the charging/discharging current and, after the initial calculation, calculates the open voltage of the battery based on the SOC which is previously estimated".

With this structural difference, the invention of Claim 3 of the present application which depends from Claim 2 has an advantage over the inventions described in References 1, 3, and 4 and combinations thereof, that, because the estimated SOC which is estimated through integration of the estimated charging/discharging current value converges to the actual SOC as time elapses, as described above, the precision of estimation of the state of charge (SOC) of the battery can be improved.

The above-described advantage is a significant advantage, and, because the invention of Claim 3 of the present application has such a significant advantage, it would not have been easy for a person with ordinary skill in the art to make the invention of Claim 3 of the present application without a difficulty based on the inventions of References 1, 3, and 4 and combinations thereof, and it is clear that the invention of Claim 3 of the present application has an inventive step.

(4) Comparison between inventions of Claims 4 and 5 of the present

application and inventions described in References 1 through 4 and 5

The invention described in Claim 4 of the present application is:

"A battery state-of-charge estimator according to either Claim 2 or 3, further comprising:

a current detector unit which detects a charging/discharging current of the battery;

an internal resistance calculator unit which calculates an internal resistance of the battery based on the measured charging/discharging current of the battery which is detected by the current detector unit and the voltage of the battery which is detected by the voltage detector unit; and

an internal resistance corrector unit which intermittently corrects the estimated internal resistance which is estimated by the internal resistance estimator unit based on the internal resistance determined by the internal resistance calculator unit".

The invention described in Claim 5 of the present application is:

"A battery state-of-charge estimator according to either Claim 3 or 4, wherein

the internal resistance corrector unit corrects a relationship between the estimated internal resistance and the temperature of the battery based on the internal resistance which is determined by the internal resistance calculator unit and the measured battery temperature".

Reference 5, on the other hand, discloses periodical calculation of an internal impedance of a secondary cell at a predetermined interval and determination of a zero-load voltage  $V_0$  using the internal impedance which is continuously updated.

Reference 5, however, fails to disclose or even suggest a structure of the invention of Claim 2 of the present application from which Claims 4 and 5 directly or indirectly depend. That is, Reference 5 fails to disclose or even suggest "an open voltage calculator unit which sets the measured voltage of the battery as the open voltage of the battery at an initial calculation of the charging/discharging current and, after the initial calculation, calculates the open voltage of the battery based on the SOC which is previously estimated".

With this structural difference, the inventions of Claims 4 and 5 of the present application which depend from Claim 2 has an advantage over the invention of Reference 5 and combinations of inventions of References 1 through 5 as described above that the estimation precision of the state of charge (SOC) of battery can be improved because the estimated SOC which is estimated through integration of the estimated charging/discharging current value converges to the actual SOC as time elapses.

This advantage is significant. Because the inventions of Claims 4 and 5 of the present application have such a significant advantage, it would not have been easy for a person with ordinary skill in the art to make the inventions of Claims 4 and 5 of the present application without a difficulty based on the inventions of References 1 and 5 and combinations thereof. Thus, it is clear that the inventions of Claims 4 and 5 of the present application have an inventive step.

Moreover, none of References 1 through 5 discloses or even suggests an element of Claim 5 of the present application that "the internal resistance corrector unit corrects a relationship between the estimated internal resistance and the temperature of the battery based on the internal resistance which is determined by the internal resistance calculator unit and the measured battery temperature".

With this structural difference, the invention of Claim 5 of the present application has an advantage that, even when the internal resistance corresponding to the battery temperature changes as time elapses, the estimation precision of the SOC of the battery as time elapses can be improve by, for example, periodically correcting and updating a correlation relationship between the battery temperature and the internal resistance of the battery.

This advantage is a significant advantage. Because the invention of Claim 5 of the present application has such a significant advantage, it would not have been easy for a person with ordinary skill in the art to make the invention of Claim 5 of the present application without a difficulty based on the inventions described in References 1 through 5 and combinations thereof. Thus, it is clear that the invention of Claim 5 of the present application has an inventive step.

(5) Comparison between the invention of Claim 9 of the present application and the inventions of References 1 through 5 and 6

The invention described in Claim 9 of the present application is:

"A battery state-of-charge estimator according to either Claim 3 or 5, wherein

the temperature detector unit is placed in the battery, on a surface of the battery, or near the surface of the battery".

Reference 6 discloses display of a remaining amount of battery by providing a temperature detector inside a battery for a portable phone and measuring an internal temperature of the portable phone.

Reference 6, however, fails to disclose or even suggest an element of the invention of Claim 2 of the present application from which Claim 9 indirectly depends. That is, Reference 6 fails to disclose or even suggest "an open voltage calculator unit which sets the measured voltage of the battery as the open voltage of the battery at an initial calculation of the charging/discharging current and, after the initial calculation, calculates the open voltage of the battery based on the SOC which is previously estimated".

With this structural difference, the invention of Claim 9 of the present application which indirectly depends from Claim 2 has an advantage over the invention of Reference 6 and combinations of References 1 through 5 and 6 that the estimation precision of the state of charge (SOC) of battery can be improved because the estimated SOC which is estimated through integration of the estimated charging/discharging current value converges to the actual SOC as time elapses.

This advantage is a significant advantage. Because the invention of Claim 9 of the present application has such a significant advantage, it would not have been easy for a person with ordinary skill in the art to make the inventions of Claims 9 of the present application without a difficulty based on the inventions of References 1 through 5 and 6 and combinations thereof. Thus, it is clear that the invention of Claim 9 of the present application has an inventive step.

(6) Comparison between the inventions of Claims 11 and 12 of the present application and the inventions described in References 1 through 5 and 7

The invention described in Claim 11 of the present application is:

"A battery state-of-charge estimator according to any one of

Claims 1 through 3, further comprising:

a current detector unit which detects a charging/discharging current of the battery;

a first battery full-capacity calculator unit which determines a full capacity of the battery based on the SOC which is estimated by the SOC estimator unit or the first SOC estimator unit and an integrated value of the charging/discharging current of the battery which is detected by the current detector unit during the estimation of the SOC; and

a third SOC estimator unit which estimates a state of charge of the battery based on the full capacity of the battery which is obtained by the first battery full-capacity calculator unit and the measured charging/discharging current of the battery which is detected by the current detector unit".

The invention described in Claim 12 of the present application is:

"A battery state-of-charge estimator according to any one of Claims 4 through 8, further comprising:

a second battery full-capacity calculator unit which determines a full capacity of the battery based on the SOC which is estimated by the first SOC estimator unit or the second SOC estimator unit and an integrated value of the charging/discharging current of the battery which is detected by the current detector unit during the estimation of the SOC; and

a fourth SOC estimator unit which estimates a state of charge of the battery based on the full capacity of the battery which is obtained by the second battery full-capacity calculator unit and the measured charging/discharging current of the battery which is detected by the current detector unit".

Reference 7, on the other hand, discloses that an ionization voltage (V), a discharging current ( $i_d$ ), and a temperature (T) of a main battery are measured during discharge of the main

battery; a reference remaining capacity at this point ( $Ah_1$ ) is calculated in relation to a remaining capacity ratio SOC (%) based on discharging characteristics; a difference  $\Delta Ah_n$  between an absolute value of a remaining capacity ( $Ah_0$ ) and the reference remaining capacity ( $Ah_1$ ) is determined with the absolute value of the remaining capacity ( $Ah_0$ ) when the remaining capacity ratio SOC is 100% being set as a fully-charged capacity  $Q_0$  (Ah); an average value  $[\Delta Ah_{N0}]$  is calculated as  $[\Delta Ah_{N0}] = ([\Delta Ah_1] + \dots + [\Delta Ah_N])/N$ ; a deterioration from the initial fully-charged capacity  $Q_{00}$  is corrected by setting the fully-charged capacity  $Q_0 = \text{initial fully-charged capacity } (Q_{00}) - [\Delta Ah_{N0}]$ ;  $Ah_{00}$  is replaced by  $Q_0$  when a difference between the absolute value of the present remaining capacity  $Ah_0$  of a fully-charge state and the fully-charged capacity  $Q_0$  is a predetermined value or greater; and a remaining capacity at the fully-charged state is determined while  $Ah_{00}$  is corrected in the equation: remaining capacity ratio SOC (%) =  $\{ [Ah_{00} \times k_i \times k_t - \int idt] / (Ah_{00} \times k_i \times k_t) \} \times 100$  (paragraphs [0016], [0017], and [0026] through [0033] and Figs. 2, 3, and 5 of Reference 7).

However, Reference 7 and References 1 through 5 described above fail to disclose or even suggest an element of the inventions of Claims 1 and 2 of the present application from which Claim 11 depends and of the inventions of Claims 1, 2, and 6 of the present application from which Claim 12 indirectly depends. That is, Reference 7 and References 1 through 5 fail to disclose or even suggest "an open voltage calculator unit which sets the measured voltage of the battery as the open voltage of the battery at an initial calculation of the charging/discharging current and calculates the open voltage of the battery based on the SOC which is previously estimated after the initial calculation".

With this structural difference, the invention of Claim 11 of the present application which depends from Claims 1 and 2 and the invention of Claim 12 which depends from Claims 1, 2, and 6 have an advantage over the inventions of References 1 through

5 and 7 and combinations thereof that the estimation precision of the state of charge (SOC) of the battery can be improved because the estimated SOC which is estimated through integration of the estimated charging/discharging current value converges to the actual SOC as time elapses.

This advantage is significant. Because the inventions of Claims 11 and 12 of the present application have such a significant advantage, it would not have been easy for a person with ordinary skill in the art to make the inventions of Claims 11 and 12 of the present application without a difficulty based on the inventions of References 1 through 5 and 7 and combinations thereof. Thus, it is clear that the inventions of Claims 11 and 12 of the present application have an inventive step.

(7) As described, none of References 1 through 7 discloses a characteristic element of the present invention and it is not possible to conceive the present invention based on these references.

In addition, none of the references discloses or even suggests a characteristic element of the present invention. That is, none of the references discloses or even suggests "an open voltage calculator unit which sets the measured voltage of the battery as the open voltage of the battery at an initial calculation of the charging/discharging current and calculates the open voltage of the battery based on the SOC which is previously estimated after the initial calculation". Therefore, it would not have been easy to make the present invention from these references, and thus, the applicant asks that the Examiner decide that there is an inventive step in Claims 1 through 6 and 9 through 12 of the present application.